Project HC-6: FUCHSIA: Fuel cell and hydrogen store for integration into automobiles

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J. D. Speight*, D. Book, A. Walton, I.R. Harris, P.P. Edwards, P. A. Anderson, U. of Birmingham, UK

D. Boyd, A. Pratt, Johnson-Matthey Technical Centre, Reading, UK

O. Gutfleisch, IFW Dresden, GERMANY

A. Züttel, U. of Fribourg, SWITZERLAND

**E-mail of Coordinator: John@birmag.fsnet.co.uk*

The objective of the FUCHSIA project (36 months) is to explore novel carbon and metallic materials giving hydrogen storage of greater than 7 wt%. The resulting material will be incorporated into a pilot hydrogen store suitable for powering a fuel cell powered light vehicle. A successful store would lead to a zero emission vehicle, if the hydrogen used were produced by a totally renewable energy source.

Following several months of evaluation, work on nano-carbon based storage materials was abandoned (early 2002). Our results suggested that the predominant mechanism of storage is physisorption and hence would not give greater hydrogen storage capability greater than 0.5 wt% at RT. Subsequently, several laboratories worldwide have verified these conclusions. In addition, over the first 24 months of FUCHSIA, a number of promising hydrogen storage materials were also evaluated notably:

- Zeolites
- Amorphous and crystalline graphites
- Activated carbons

None of these materials were found to have hydrogen storage parameters suitable for use in conjunction with a light vehicular fuel cell storage system. However, some were worthy of further consideration for other hydrogen storage applications and work on them has continued under other programmes.

Alanates and lithium borohydrides were also explored in this period of the project. Both materials have promise as sources of hydrogen, but at present, there are no catalysts capable of accelerating the reabsortion of hydrogen into these materials under practical conditions of time, temperature and pressure.

In the final year the FUCHSIA work programme has narrowed to focus on the synthesis and characterization of Magnesium-based alloys.

Mg-based alloys were high velocity milled (HVM) under hydrogen in the presence of transition-metal catalysts. This processing route appears to alleviate the two main deficiencies of Mg and Mg-based alloys as potential hydrogen stores i.e.: the high temperatures (>250˚C) and slow rate of release of stored hydrogen.

Work has shown that catalysts, milling conditions and the elimination of surface oxidation have profound effects on the performance of Mg-alloys as hydrogen stores. The best properties obtained were with a dilute Mg-Ni alloy HVM for 80 hours, followed by the addition of 0.5-1 wt% PGM and a final HVM for 1 hour. Pre-production quantities of this alloy will be produced and various engineering properties will be measured (including hydrogen cycling performance and thermal conductivity). In the final stages of the project, this material will be incorporated into a prototype high-temperature (~300˚C) store which will interface with a PEM fuel cell.